

The larval development of the Angular Crab, *Goneplax rhomboides* (Linnaeus) (Decapoda: Brachyura)

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Introduction

The Angular Crab, *Goneplax rhomboides* (Linnaeus) occurs in the Eastern Atlantic Ocean and Mediterranean Sea. It has been reported from the northern Irish Sea to as far south as the Cape region of South Africa (see Barnard, 1950 : 285; Ingle, 1980 : 109); the species occurs from the lower shore to depths of about 700 m.

Capart (1951 : 169) discussed regional variation of this species with respect to the degree of development of the posterior pair of carapace antero-lateral teeth and differences in shapes of the male first pleopod. He suggested two 'varieties' may exist. Specimens attributed to *G. rhomboides* (L.) have a very rudimentary pair of posterior teeth and are reported only from the Mediterranean Sea, coast of Mauritania and the Canary Islands whereas material assigned to *G. angulata* (Pennant) has been recorded from various Atlantic Ocean localities (see Manning & Holthuis, 1981 : 164).

The larval stages of *G. rhomboides* have been described previously (see larval and post-larval references below), but these accounts are generally inadequate for use in detailed comparative studies of larval morphology. The recent rearing of *G. rhomboides* to third crab stage has provided sufficient material for redescribing the complete larval development of this species and an account is given here of the four zoeal and megalop stage.

Materials and Methods

After several unsuccessful trawling attempts, SCUBA diving was used to collect ovigerous material. On the advice of Alan Howard (MAFF) members of the BM(NH) Diving Unit searched the sandy-mud substrate to a depth of 18m off Shoalstone Point (SX937568), Brixham, Devon. An ovigerous crab was collected on 10 July 1981 and transported to the rearing laboratory of the Crustacea Section, BM(NH). The larvae were reared using methods described by Rice & Ingle (1975) and Ingle & Clark (1977), except that sea water was untreated. Drawings and measurements were made with the aid of a *camera lucida*. Measurements are as follows: total lengths of zoeae (T.T.) measured from tip of dorsal to tip of rostral spine and carapace length (C.L.) measured from between eyes to postero-lateral margin of carapace (for zoeae) and from rostral tip for megalop. All material was fixed in Steedman's preservative (Steedman, 1976 : 148) and later transferred to 70% ethanol alcohol. The female and larval stages are deposited in the collections of the BM(NH), accession numbers 1981 : 540 & 1982 : 55 respectively.

Descriptions

Goneplax rhomboides (Linnaeus, 1758)

non *Goneplax rhomboides*:-Cano, 1891, Tav. XI, figs 1D (or ?E), IX^d, IX^e (megalops); *Brachynotus sexdentatus*:-Cano, 1891, Tav. XI, fig. 1F (crab stage); non *Goneplax rhomboides*:-Williamson, 1915,

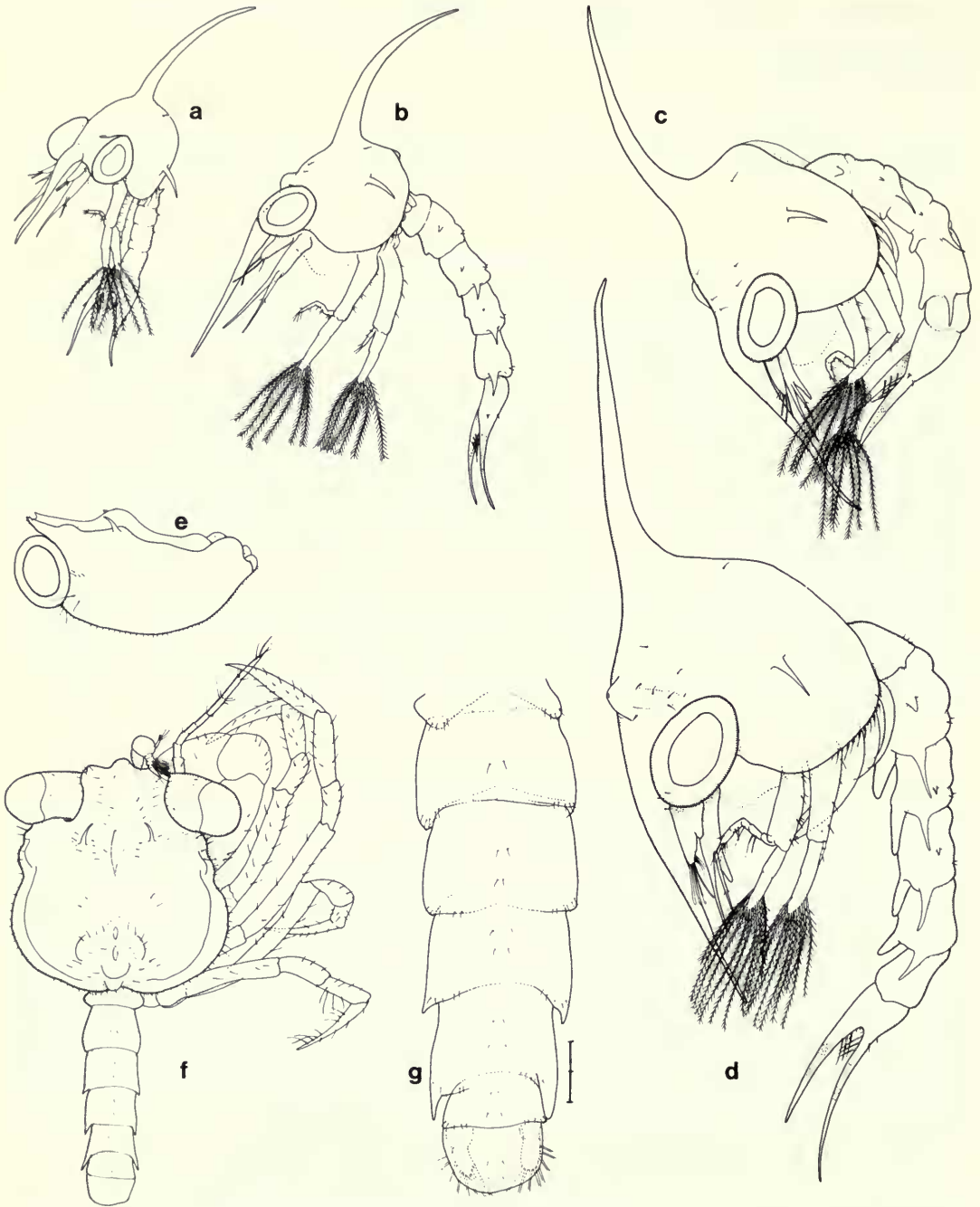


Fig. 1 *Goneplax rhomboides* (L.): a-d 1st-4th zoeae; e megalopal carapace from left lateral aspect f; megalop from dorsal aspect; g moult of megalopal abdomen slightly flattened to show setation; scale, each division = 0.1 mm.

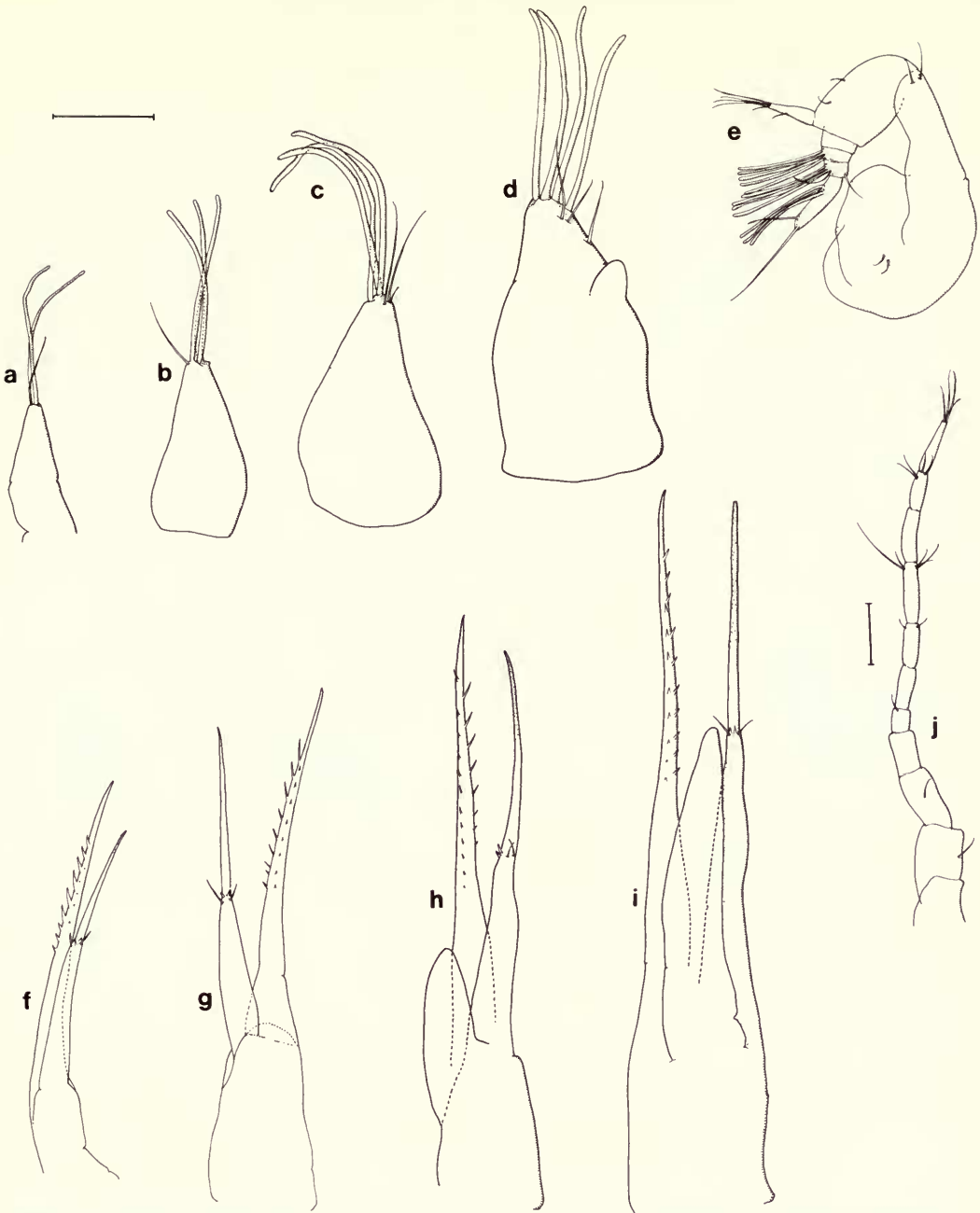


Fig. 2 *Goneplax rhomboides* (L.): a-d antennule of 1st-4th zoea respectively and e of megalop; f-i antenna of 1st-4th zoea and j of megalop respectively; scale = 0.1 mm.

fig. 398 (after Cano); *Gonoplax angulata*: Caroli, 1927: 161 (1st-4th zoeae, megal., describ.); *Gonoplax rhomboides*: Lebour, 1928: 534, figs 4 (6-9), 5 (22-24), Pl. II, fig. 6, Pl. XI, fig. 10, Pl. XII, figs 1-4 (1st-4th zoeae, megal., 1st-4th crab); *Gonoplax angulata*: Bourdillon-Casanova, 1960: 180, figs 57a-c (1st zoea, megal.); *Goneplax rhomboides*: Rice & Williamson, 1977: 55, fig. 29 (3rd zoea).

FIRST ZOEAE

Dimensions: T.T. 1.5 mm, C.L. 0.5 mm.

Carapace (Fig. 1a): Dorsal, rostral and lateral spines present; a pair of postero-dorsal

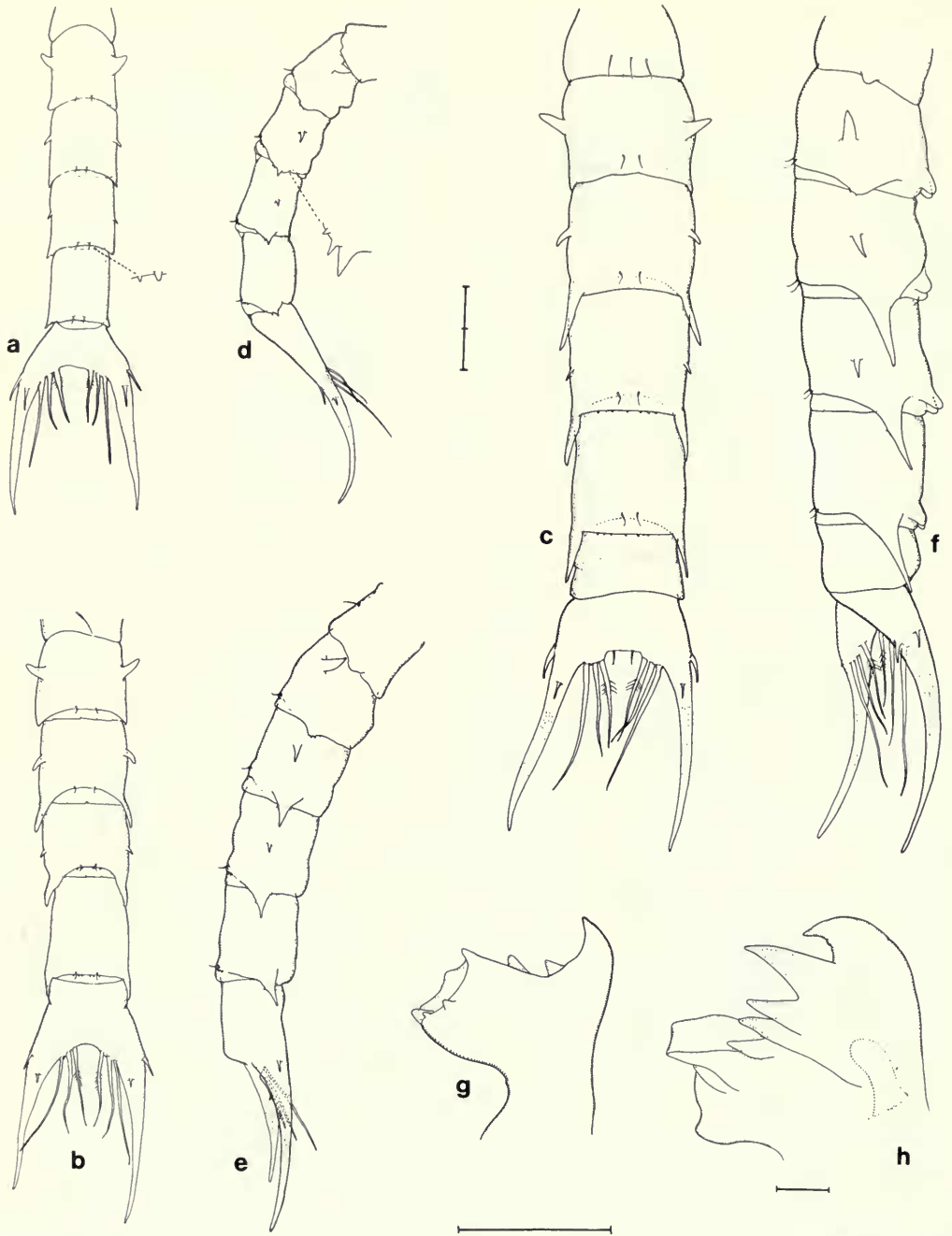


Fig. 3 *Goneplax rhomboides* (L.): a-c abdomen and telson of 1st-3rd zoea respectively from dorsal aspect and d-f same from lateral aspect; g, h left half of mandible of 1st and 4th zoea respectively (drawn from scanning EM photographs); scale, each division=0.1 mm except h=30 μ .

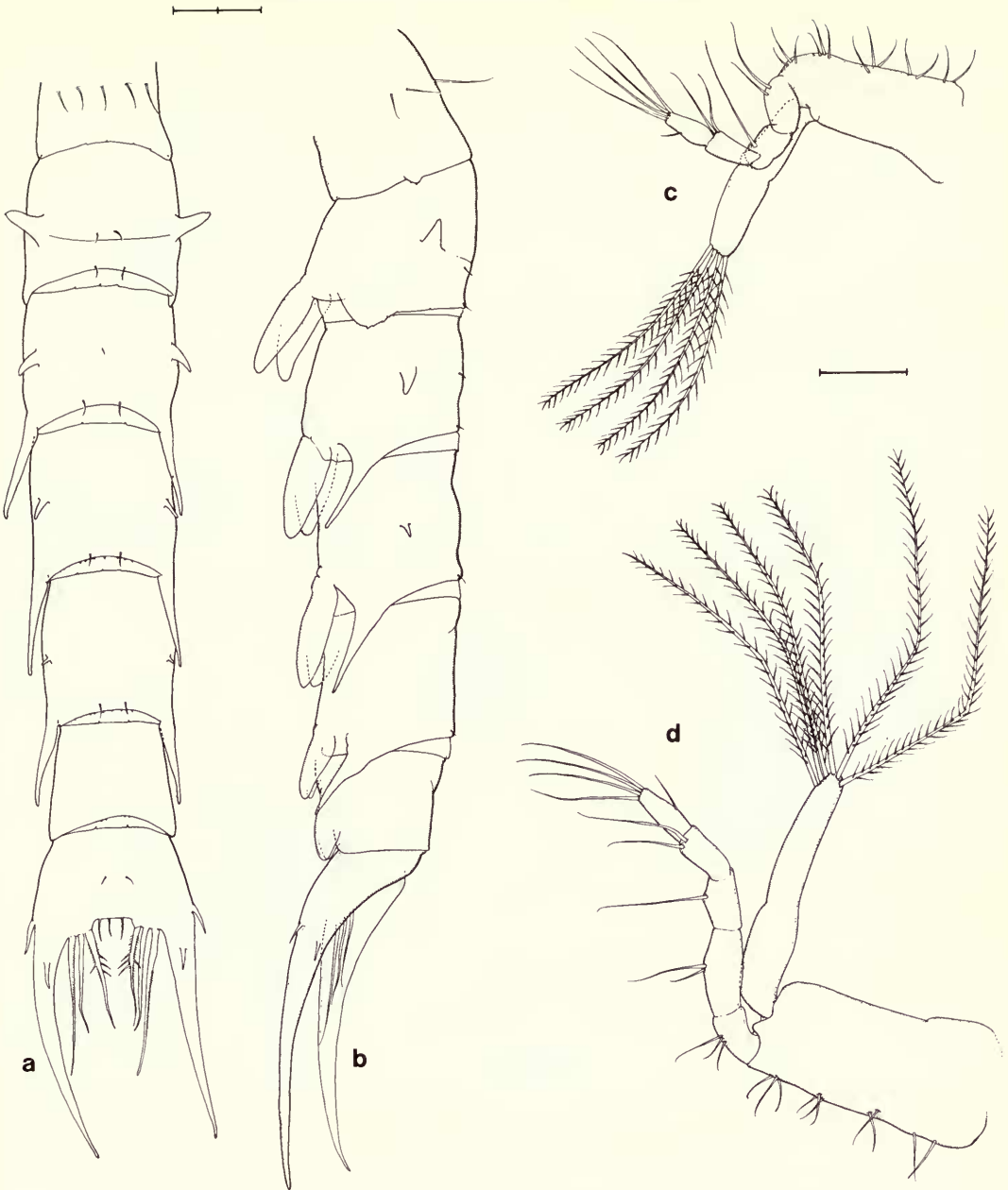


Fig. 4 *Goneplax rhomboides* (L.): a abdomen and telson of 4th zoea from dorsal aspect; b of another specimen from lateral aspect; c, d 1st maxilliped of 1st and 2nd zoea respectively; scale, each division = 0.1 mm.

setules; dorso-median elevation present; posterior margin of carapace minutely serrate and with 3–4 setules.

Eyes: Partly fused to carapace.

Antennule (Fig. 2a): Exopod unsegmented, with 2 terminal aesthetascs and one seta.

Antenna (Fig. 2f): Exopod with very minute spinules distally and with 2 median spinules and 2 setules; spinous process distally spinulate, slightly longer than exopod.

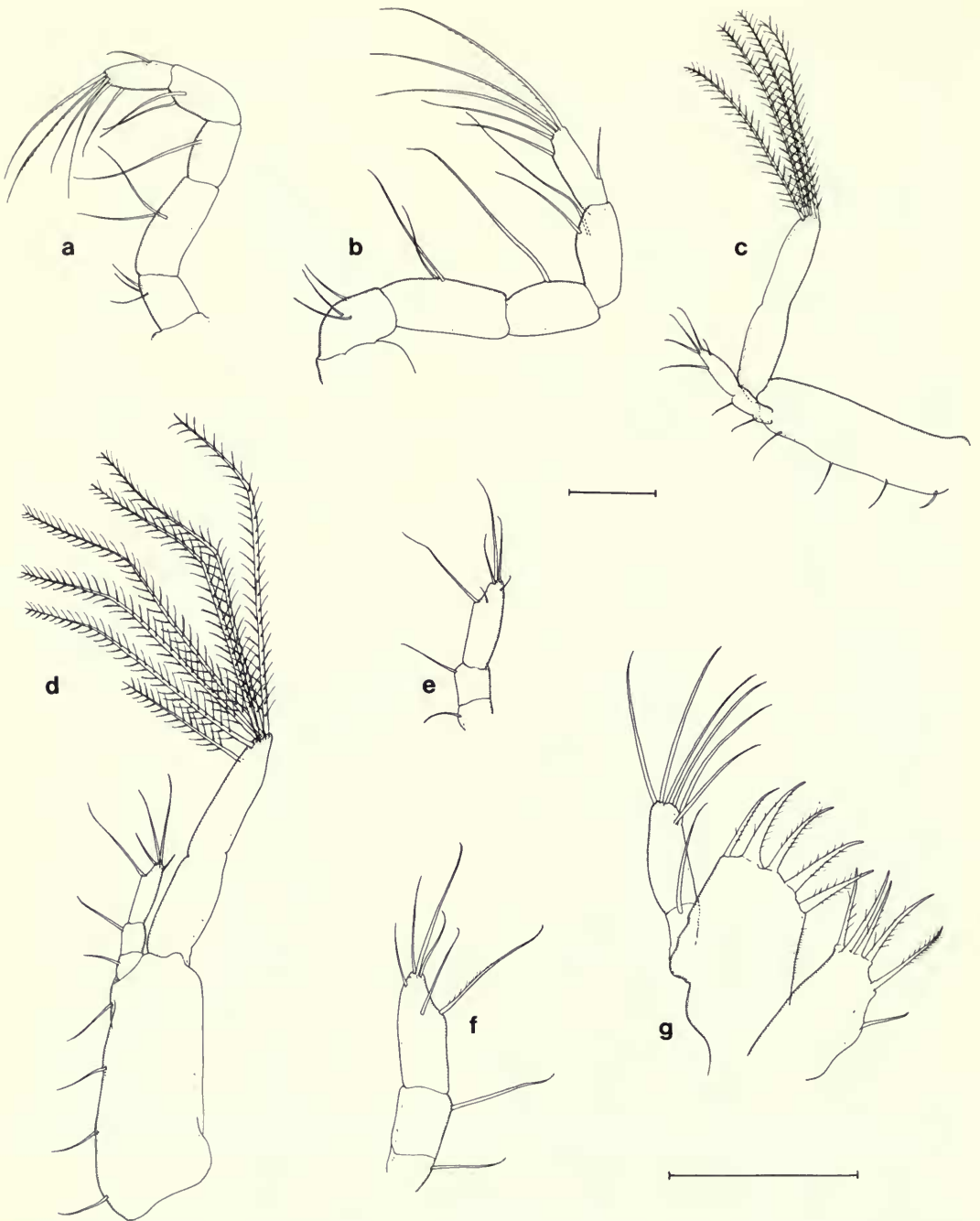


Fig. 5 *Goneplax rhomboides* (L.): a, b 1st maxilliped endopods of 3rd and 4th zoea respectively; c, d 2nd maxillipeds of 1st and 2nd zoea and e, f 2nd maxilliped endopods of 3rd and 4th zoea respectively; g maxillule of 1st zoea; scale = 0.1 mm.

Mandible (Fig. 3g): Incisor and molar processes developed.

Maxillule (Fig. 5g): Endopod 2-segmented, proximal segment with one seta, distal with 2 sub-terminal and 4 terminal setae; basal endite with one seta and 4 spines on distal margin; distal and inner margins of coxal endite with a total of 6 setae.

Maxilla (Fig. 7a): Scaphognathite with 4 long plumose setae and one distal stout posterior process; endopod bilobed, with 5+3 setae; basal endite unequally bilobed, with 4+5 setae; coxal endite bilobed with 4+4 setae.

First maxilliped (Fig. 4c): Exopod incipiently 2-segmented, with 4 terminal plumose setae; endopod 5-segmented, with 3, 2, 1, 2, 4+1 setae; margin of basis with 2, 2, 3, 3 setae.

Second maxilliped (Fig. 5c): Exopod incipiently 2-segmented, with 4 terminal plumose setae; endopod 3-segmented, with 1, 1, 4+1 setae; margin of basis with 4 setae.

Third maxilliped: not developed.

Pereiopods: not developed.

Abdomen (Figs 3a, d): 5-segmented+telson, segments 2-4 each with a pair of lateral processes decreasing in size on each respective segment; postero-lateral margins of segments with minute denticles as shown in inset to Fig. 3d; margin of segment 2 produced and rounded, those of 3-5 with acute processes; each postero-dorsal margin of segments 3-5 with minute denticles and of 2-5 with a pair of small setules. Telson broad, one long dorsal and one lateral spine on each fork; posterior margin concave, with 3 spines on each outer half, outermost pair longest; middle portion of telson forks invested with minute spinules.

SECOND ZOEAE

Dimensions: T.T. 1.9-2.0 mm, C.L. 0.6-0.7 mm.

Carapace (Fig. 1b): Now with 2 pairs of antero-dorsal setules, 4-6 setules on posterior margin and a prominent dorso-median elevation; eyes free.

Antennule (Fig. 2b): Exopod now with 3 terminal aesthetascs.

Antenna (Fig. 2g): Exopod setules longer than in previous stage, an incipient endopod bud present.

Mandible: Unchanged.

Maxillule (Fig. 6a): Endopod now conspicuously stepped distally; basal endite with a prominent plumose seta on outer margin, distal and inner margins with a total of 3 setae and 5 spines; distal and inner margins of coxal endite with a total of 7 setae.

Maxilla (Fig. 7b): Scaphognathite now with 12 marginal setae.

First maxilliped (Fig. 4d): Exopod now with 6 terminal plumose setae.

Second maxilliped (Fig. 5d): Exopod now with 7 terminal plumose setae.

Third maxilliped: represented as a small bud.

Pereiopods: represented as small buds.

Abdomen (Figs 3b, e): Dorsal surface of 1st segment with one seta, postero-lateral margin now slightly produced, lateral processes on segment 2 and postero-lateral processes on 3-5 longer than in previous stage.

THIRD ZOEAE

Dimensions: T.T. 2.8-2.9 mm, C.L. 1.1-1.2 mm.

Carapace (Fig. 1c): Now with 5 pairs of antero-dorsal setules and 7-10 setules on posterior margin.

Antennule (Fig. 2c): Exopod now with 3 setules and 3 setae.

Antenna (Fig. 2h): Endopod bud well developed.

Mandible: Incisor sub-divided.

Maxillule (Fig. 6b): Basal endite now with 3 setae on distal margin and with a total of 9 setae on distal and inner margins of coxal endite.

Maxilla (Fig. 7c): Scaphognathite now with 20 setae, basal endite with 5+5 and coxal with 4+5 setae.

First maxilliped (Fig. 5a): Exopod now with 8 terminal plumose setae; distal segment of endopod now with 5+1 setae.

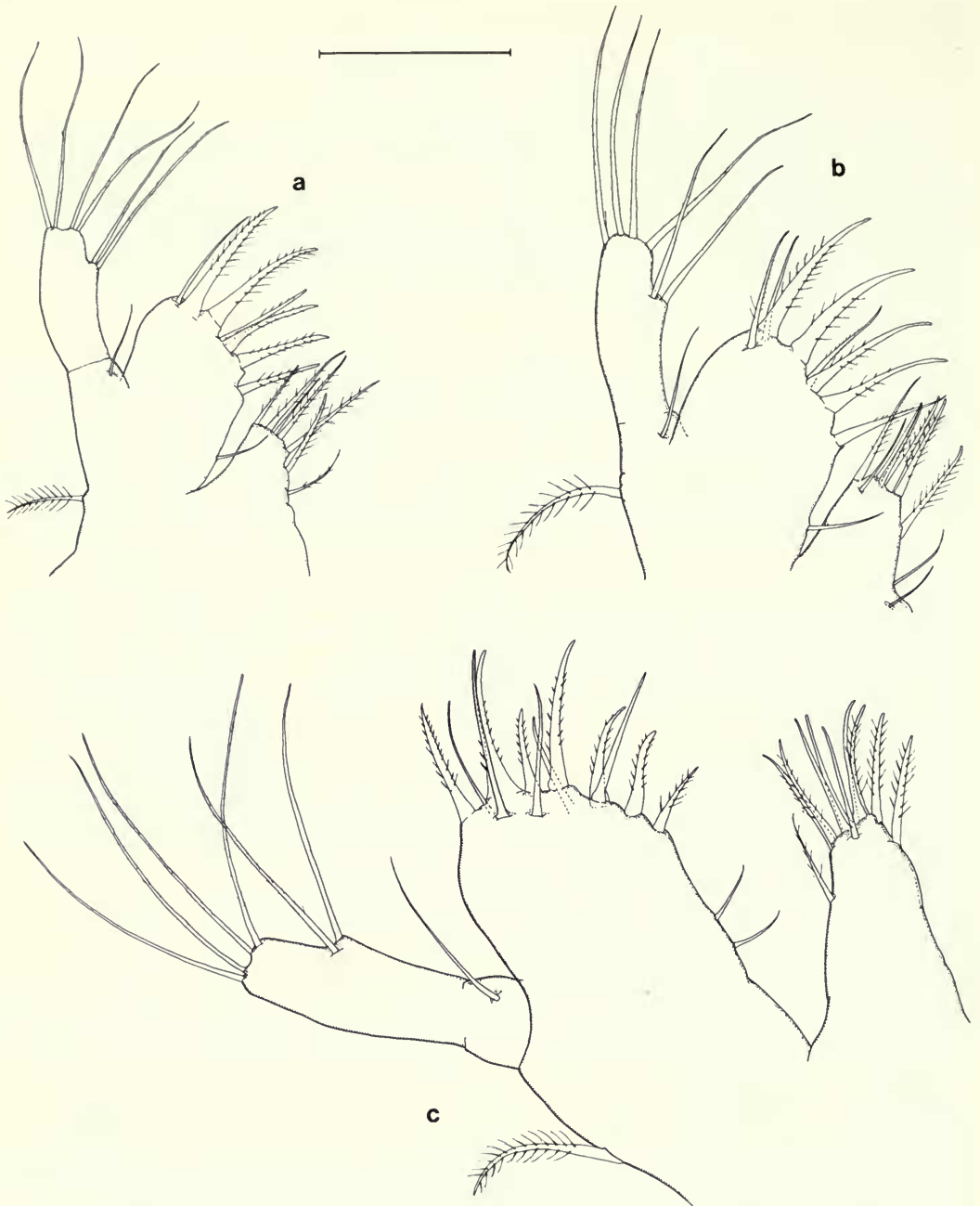


Fig. 6 *Goneplax rhomboides* (L.): a-c maxillule of 2nd-4th zoea respectively; scale=0.1 mm.

Second maxilliped (Fig. 5e): Exopod now with 8 terminal plumose setae; distal segment of endopod with 5 + 1 setae.

Third maxilliped: represented as a conspicuous biramous bud.

Pereiopods: rudimentary but conspicuous, first pair incipiently chelate.

Abdomen (Figs 3c, f): Now 6-segmented + telson; a minute lateral process on segment 5 in some specimens; postero-lateral processes on segments 3-5 longer than in previous stage;



Fig. 7 *Goneplax rhomboides* (L.): a, b maxilla of 1st and 2nd zoea; c, d endopod, basal and coxal endites of maxilla of 3rd and 4th zoea respectively; scale = 0.1 mm.

dorsal surface of 1st segment now with 3 setae; rudimentary paired pleopods on segments 2-5.

FOURTH ZOEAE

Dimensions: T.T. 3.5-3.6 mm, C.L. 1.4-1.5 mm.

Carapace (Fig. 1d): Now with 8 or more pairs of antero-dorsal setules, 2 pairs at base of

rostral spine and sometimes a small setule on each eye; 12–15 setules on posterior margin of carapace.

Antennule (Fig. 2d): Exopod now with 4 terminal aesthetascs and short setae; endopod represented as an incipient bud.

Antenna (Fig. 2i): Exopod now with conspicuous distal spinules; endopod bud more than half length of exopod.

Mandible (Fig. 3h): Incisor and molar processes sub-divided as shown.

Maxillule (Fig. 6c): Distal and inner margins of basal endite now with a total of 7 setae and 7 spines; margins of coxal endite with a total of 10 setae.

Maxilla (Fig. 7d): Scaphognathite now with 31 marginal setae; margins of basal endite with 6 + 6 and coxal with 4 + 6 setae respectively.

First maxilliped (Fig. 5b): Exopod now with 9 terminal plumose setae; distal segments of endopod proportionally slightly longer than in previous stage.

Second maxilliped (Fig. 5f): Exopod now with 10–11 terminal plumose setae; segments of endopod proportionally longer than in previous stage.

Third maxilliped: more conspicuous than in previous stage.

Pereiopods: more developed than in previous stage.

Abdomen (Figs 4a, b): Segment 6 now with minute denticles on postero-dorsal margin and with a pair of pleopods; segments 1, 2, 3 with 5, 4, and 3 dorsal setae respectively; pleopods biramous. Medio-posterior margin of telson with 3 setae, dorsal surface with a pair of median setae.

MEGALOP

Dimensions: C.L. 1.8–1.9 mm.

Carapace (Figs 1e–f): Rostrum small, slightly deflected ventrally; mesogastric region with a prominent longitudinal carina; each half of protogastric region with a prominent curved spine; cardiac and intestinal regions with carinae and broad tubercles arranged as shown in Fig. 1f; margin of carapace with numerous small setules.

Antennule (Fig. 2e): Peduncle 3-segmented, with 2 setae on each segment; exopod 4-segmented with 0, 5, 4, 3 aesthetascs and 0, 0, 2, 2 setae respectively; endopod unsegmented, with one sub-terminal and 5 terminal setae.

Antenna (Fig. 2j): Peduncle 3-segmented, with 1, 1, 0 setae and flagellum 7-segmented with 1, 0, 2, 5, 0, 4, 4 setae respectively.

Mandible (Fig. 9e): Molar process now reduced, palp 3-segmented, with 0, 1, 8 setae respectively.

Maxillule (Fig. 8a): Endopod now reduced and unsegmented, with 2 terminal setae; margins of basal endite with a total of 13 setae and 8 spines; margins of coxal endite with a total of 15 setae/spines.

Maxilla (Fig. 8b): Scaphognathite with 51 marginal setae and 4 setae on dorsal surface, posterior margin sub-truncate; endopod reduced to a sub-acute lobe with setae on outer margin; basal endite with 8 + 7 marginal setae and with additional setae on dorsal and ventral surfaces as shown; coxal endite with 6 + 9–10 setae.

First maxilliped (Fig. 8c): Coxal segment with 6–7 setae, basis with 26–28 setae; endopod represented as a broad sub-acute lobe invested with 3–4 setae; exopod 2-segmented, with 3 and 5 setae respectively; epipod well developed, with 6 long setae.

Second maxilliped (Fig. 8d): Coxal segment hardly differentiated from basis, with 5–6 setae, ischium to dactylus differentiated, with 0, 3, 1, 4, 5 setae respectively in addition to 4 spines on dactylar margin; exopod 2-segmented, with 2 and 4 setae respectively; 2 setae at basis–exopod junction; epipod short, with 3 distal setae.

Third maxilliped (Fig. 9a): Coxa not differentiated from basis, with 4–5 setae as shown; outer margin of ischium with 1–2 broad, acute spines and with 19–20 setae; merus to dactylus well differentiated and with 11–12, 5, 7, 6 setae respectively; exopod 2-segmented, with 1 and 5 setae respectively; epipod long, with numerous short setae in proximal half (*circa* 18) and 15 long medio- to distally placed setae.

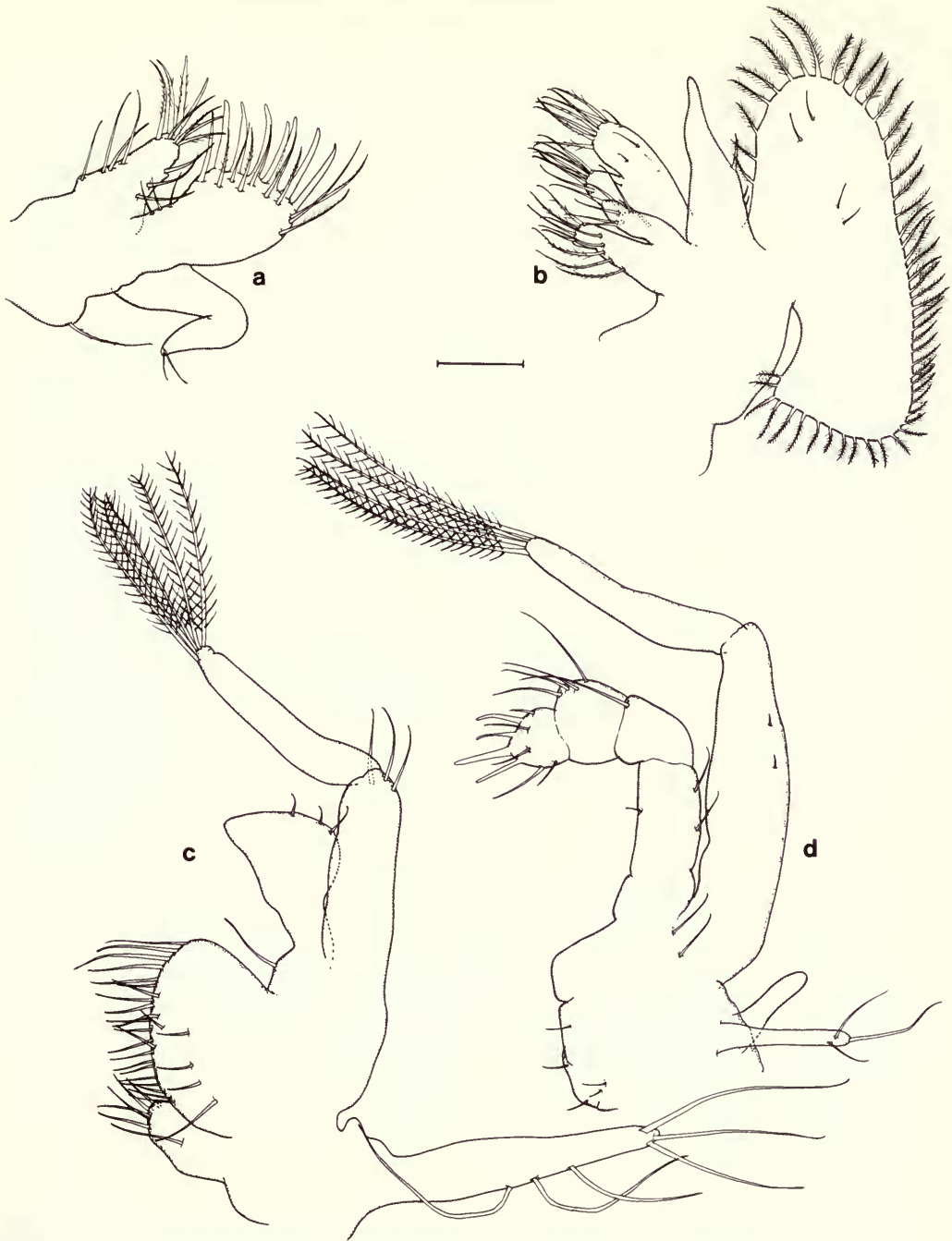


Fig. 8 *Goneplax rhomboides* (L.): megalop – a maxillule; b maxilla; c 1st maxilliped; d 2nd maxilliped; scale = 0.1 mm.

Pereiopods (Figs 9b–d, 10a, b, i): Cheliped stout, invested with numerous setae as shown in Fig. 9b; one large and one small ischial spine present; inner margin of propodal extension with 2–3 processes, inner margin of dactylus without processes. *Pereiopods* stout, setose as shown in Figs 9c, d & 10a, b; coxal-ischial segments of pereiopods 2–4 each with a well developed spine; dactylus of 5th pereiopod with 3 long setae on inner distal margin.

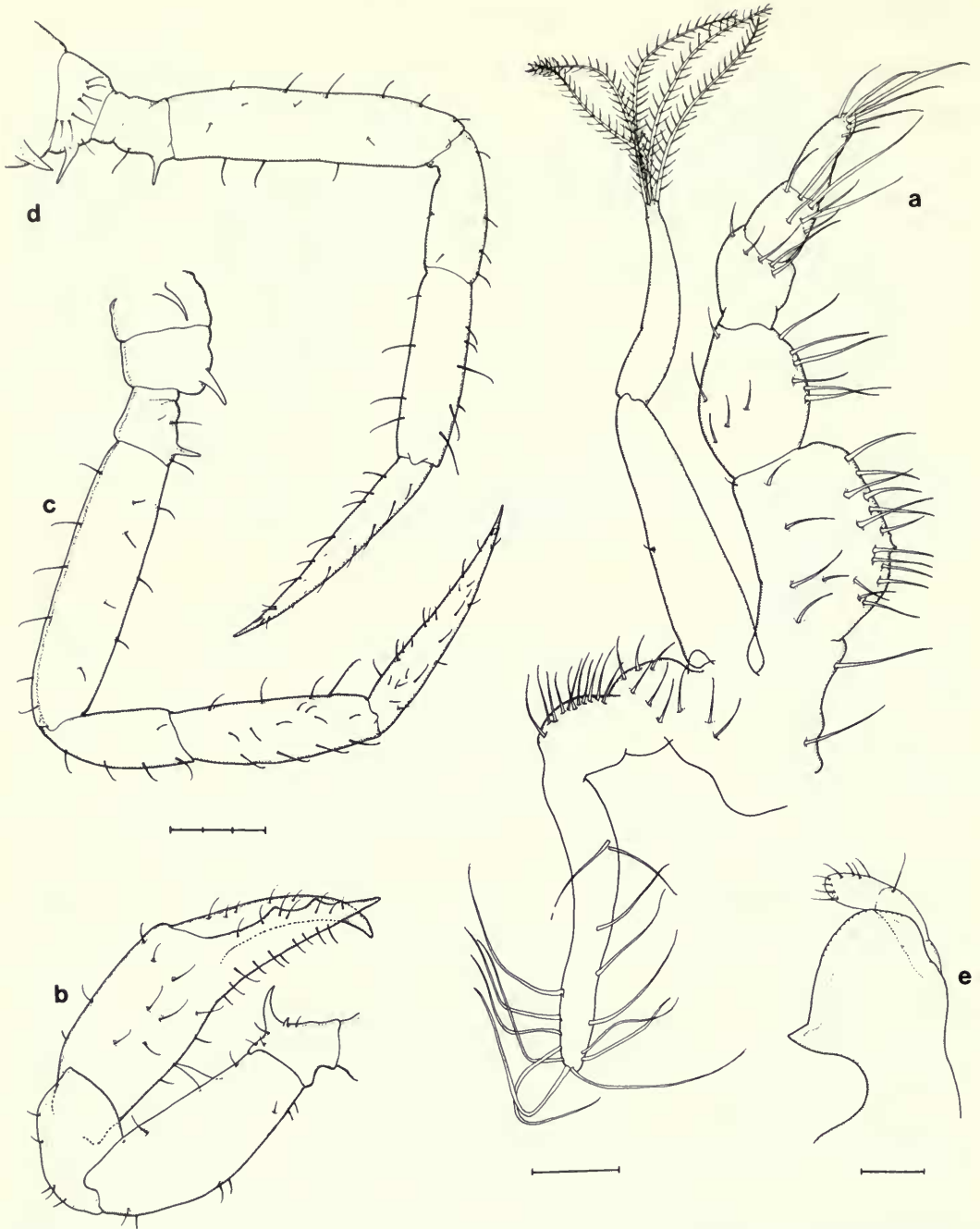


Fig. 9 *Goneplax rhomboides* (L.): megalop – a 3rd maxilliped; b left cheliped; c 2nd pereopod; d 3rd pereopod; e mandible; each division of scale = 0.1 mm.

Cephalothorax (Fig. 10i): Second to 4th sternites each with a prominent curved spine and a seta, first segment of sternum also with a small spine and numerous setae.

Abdomen (Figs 1f, g & 10h): 6-segmented + telson; posterior-lateral margin of first segment sub-acute, of 2nd truncate, of 3rd–5th acutely produced and of 6th sub-truncate. Surfaces of segments invested with numerous setae distributed as shown in Fig 1g. Well developed

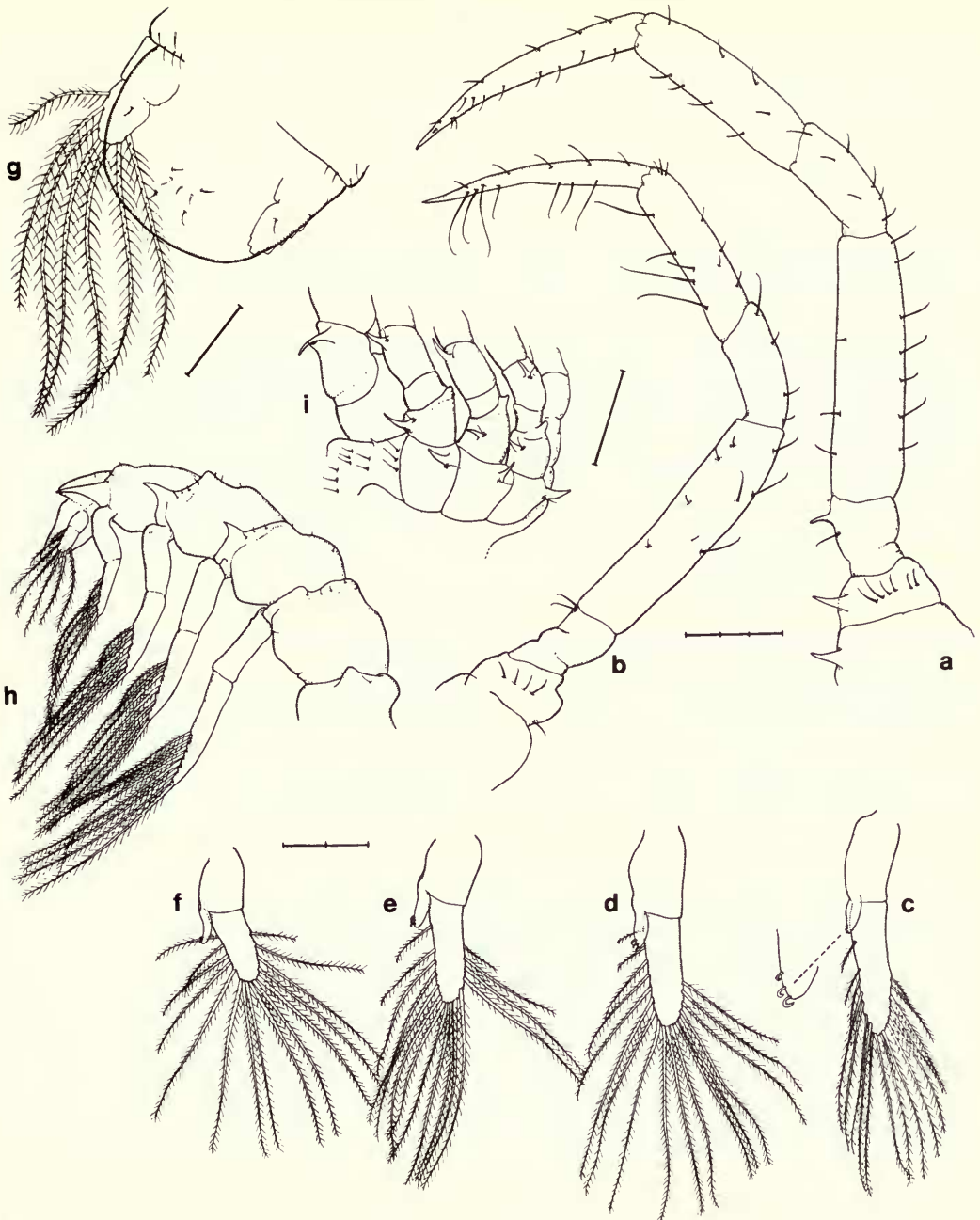


Fig. 10 *Goneplax rhomboides* (L.): megalop—*a-b* 4th and 5th pereopods and *c-f* 1st–4th pleopods respectively; *g* telson and left uropod from dorsal aspect; *h* abdomen from right lateral aspect; *i* sternites and coxal-ischial segments of pereopods from left side, ventral aspect; scale, each division=0.1 mm.

biramous pleopods on segments 2–5, exopods with 17, 17, 16, 15 long plumose setae on 1st–4th pairs (Figs 10*c-f*) respectively; inner distal margin of endopod of each with 3 coupling hooks. Uropods (Fig. 10*g*) well developed, distal segment with 7–8 long plumose setae. Telson much broader than long, dorsal surface with a pair of lateral and 2 pairs of median setules, ventral surface with 3–4 small setules.

Remarks

The present laboratory reared material of *G. rhomboides* differs in a number of features from the accounts given by Bourdillon-Casanova (1960) and Rice & Williamson (1977). These differences are tabulated below.

Bourdillon-Casanova	Present material
ZOEAE I	ZOEAE I
Denticles on proximal part of postero-lateral margin of abdominal segments very pronounced.	Denticles on proximal part of postero-lateral margin of abdominal segments very minute.
MEGALOP	MEGALOP
Disto-lateral margins of rostrum very acute. Protogastric spines of carapace stout and straight. A pair of widely spaced tubercles on meta-branchial-intestinal regions. Groups of setae on posterior region of carapace	Disto-lateral margins of rostrum not acute. Protogastric spines of carapace thin and curved. A pair of tubercles placed near to median line on cardiac region. Without groups of setae on posterior region of carapace.
Exopod of uropod with 8-9 setae	Exopod of uropod with 7-8 setae.
Rice & Williamson	
ZOEAE III	ZOEAE III
Antennal exopod with a single mid-point seta.	Antennal exopod with more than one seta/spinule at mid-point.
Scaphognathite of maxilla with 18-19 setae.	Scaphognathite of maxilla with 20 setae.
Endopod of 2nd maxilliped with 1, 1, 5 setae.	Endopod of 2nd maxilliped with 1, 1, 6 setae.
ZOEAE I-IV	ZOEAE I-IV
Exopod terminal segment of 2nd maxilliped with 4, 7, 9, 11 setae in respective stages.	Exopod terminal segment of 2nd maxilliped with 4, 7, 8, 10-11 setae in respective stages.

With the exception of *Geryon tridens* (Kröyer), the zoeae of *Goneplax rhomboides* can be distinguished from those of other known brachyrynchs occurring in the N.E. Atlantic sea area (see Ingle, 1980) by the following combined features: (1) A pair of small but prominent dorso-lateral processes on the 4th segment of the abdomen and sometimes a minute pair on the 5th segment in the 3rd and 4th stages. (2) The antennal exopod with spinules and setae sub-terminally placed. Features separating zoeae of *G. rhomboides* from those of *Geryon tridens* were tabulated by Ingle (1979 : 229). The following amendments must now be made to this table with respect to *G. rhomboides*: (1) The antennal exopod—the spinous process is longer than the exopod in all stages. (2) Maxilla of ZIII-scaphognathite with a maximum of 20 setae on margin. (3) 1st maxilliped-endopod setae of ZIII, *G. tridens* 2, 2, 1, 2, 5 + 1 and *G. rhomboides* 3, 2, 1, 2, 5 + 1 respectively.

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